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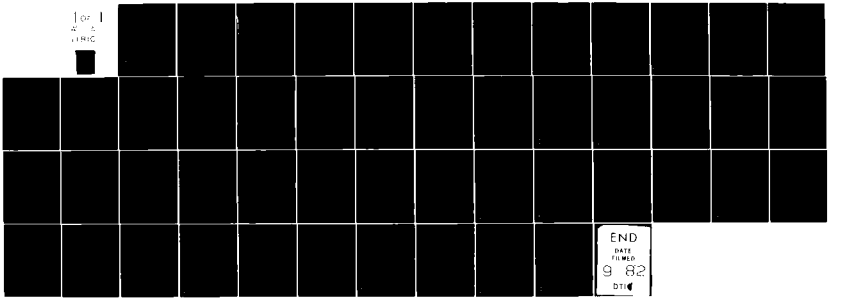

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IMPORTANCE OF TOPOGRAPHIC FEATURES AND TACTICAL ANNOTATIONS ON MAPS USED BY ARMY AVIATORS FOR NAP-OF-THE-EARTH FLIGHT

Report No. 459-1

Prepared for:

ADVANCED SYSTEMS DIVISION (DAVAA-F)
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January 1982

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes a survey conducted to assist in the definition of requirements for the display of topographic and tactical information for Army aviators. The introductory section of the report describes Army Aviation tasks, difficulties with map use in the performance of these tasks, and the solution of these difficulties through the development of a computer-generated topographic display system. The general objective of the reported project was to support the development of such a computer-based system through identification of the most important

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topographic and tactical features used in meeting Army aviation mission requirements. One hundred and seven Army aviators participated in the project, completing an extensive survey by rating the importance and frequency of use of specific features. The report presents a series of tables summarizing the results of the project including average importance ratings of each feature, and rankings of features by importance ratings. A discussion of the overall pattern of results is also provided.

ACKNOWLEDGMENTS

The required information content of a map can only be defined by reference to the specific purposes for which it is intended to be used. It follows that only experienced Army aviators can be expected to understand map requirements for nap-of-the-earth flight in the high-threat environment. The author is deeply indebted to the following aviators for their contribution of time and expertise:

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INTRODUCTION

This report describes a survey conducted to assist in the definition of requirements for the display of topographic and tactical information for Army aviators. The project was undertaken as partial fulfillment of the requirements of Contract No. DAAK80-81-C-0089, issued by the U.S. Army Communications Research and Development Command, in support of the Avionics R&D Activity at Fort Monmouth, New Jersey.

This introductory section of the report describes the background leading up to the conduct of the survey, the project objectives, and the organization of the report.

BACKGROUND

ARMY AVIATION TASKS

During the past three decades, Army aviation has been tasked with an ever-broader range of missions. Today, helicopters are an integral component of the combined arms team and perform a great variety of tasks. Army aviators must be prepared to enhance the ground commander's capabilities in one or more of the five functions of land combat: firepower, mobility, intelligence, command and control, and combat service support. Furthermore, Army aviators are expected to provide a rapid response over a wide area of operations. Thus, as the aviators' responsibilities have grown, the time available for their performance has diminished. Nevertheless, they are expected to plan and conduct their missions with great precision, and maintain accurate geographic orientation at all times. These demands are particularly formidable because of the extremely low altitudes of flight required for survival in the high-threat environment. It may be necessary to employ low-level, contour, or nap-of-the-earth (NOE) flight techniques. Low-level flight generally employs a constant heading, altitude, and airspeed. Contour flight is conducted in very close proximity to the ground and requires altitude changes to conform to the contour of the earth, while maintaining a generally constant heading. NOE flight is flight as close to the earth's surface as vegetation and obstacles will permit, varying course, airspeed, and altitude in order to take

maximum advantage of the cover and concealment offered by terrain, vegetation, and man-made features. In practice, the aviator may use a combination of these three techniques during a single mission.

In order to identify Army aviation tasks with great specificity, it is necessary to consider the type of aviation unit, the type of aircraft, the type of unit supported, and the type of tactical situation. The type of aviation unit must be considered because the missions are different for assault helicopter units, attack helicopter units, air cavalry units, and assault support units. The type of aircraft must be taken into account because scout, utility, and attack aircraft are, of course, designed for different purposes, and their missions in the combined arms team are defined so that these differences complement each other. The roles of aircraft types, however, vary according to the type of aviation unit. For example, attack helicopters in assault helicopter units are used to protect the utility aircraft. In attack helicopter units, however, the same type of aircraft are used to seek out and destroy enemy armor. The type of ground unit supported also has much to do with the mission. Helicopters may be used in support of infantry, armor, artillery, and other units. The type of tactical situation has a very strong influence on the mission. Depending upon the tactical situation, helicopters may serve in gathering intelligence, raiding the enemy rear or flanks, blocking enemy forces, reinforcement, exploitation, covering forces, and many other operations. Although Army aviation tasks are extremely varied, certain generalizations can be made regarding map use by aviators.

MAP USE IN ARMY AVIATION

Map use in support of Army aviation consists of four distinct categories of activity: mission planning, navigation, recovery from disorientation, and tactical decision-making.

1. Mission Planning

Extensive mission planning activities are required of the Army aviator. The successful accomplishment of many of these activities depends upon the aviator's ability to extract information from maps. At a minimum, the aviator must study and visualize the overall situation and topography; select engagement points,

observation points, or landing zones; determine primary and alternate (masked) routes of flight; select air control points, checkpoints, and barrier features; and determine flight techniques, altitudes, speeds, and durations.

2. Navigation

Given the nature of the high threat environment, it is unlikely that aviators will be able to make use of radio navigation aids. Dead reckoning (computing direction and distance from a known position) is unreliable given the si ·ous course and variable speed of NOE flight. Thus navigation must often be perfo ed only by "pilotage"—by identifying visible landmarks, and correlating them features depicted on the map.

Pilotage at NOE altitudes is a formidable task due to the pilot's ed view of the surrounding terrain. The features that mask the enemy's view of the helicopter also serve to mask the pilot's view of navigational checkpoints. The pilot's view of the surrounding topography may be limited to features within as little as 100 meters from the aircraft. Landforms often cannot be seen in their entirety and the low angle of view adds to the difficulty of ascertaining their contours. Other features, including vegetation patterns, hydrographic information, and man-made objects visible to the aviator, may or may not be depicted on the map depending upon cartographic constraints.

3. Reorientation

Temporary geographic disorientation is a relatively common event in Army aviation units. When visibility is degraded by darkness or atmospheric attenuation, or when hostile fire distracts the aviator, the likelihood of disorientation increases markedly. It is important to recognize that the aviator performs different tasks in reorientation than he does during mission-planning or navigation activities. In mission-planning, the aviator can study a given position on the map, but must infer from the symbology how the actual terrain would be likely to appear from that position. On the other hand, when he is disoriented, the aviator can examine the surrounding terrain, but must deduce how that terrain would be symbolized on a map.

In navigation, the aviator's task is one of "keeping track" of the position of the aircraft within a small area of uncertainty by correlating features shown along

the planned route on the map with the features actually passed in the terrain. The disoriented pilot, in contrast, faces a "problem-solving" task and must perform analyses of the terrain to determine his position, often with no information regarding what features he should expect to see because the area of uncertainty is very large.

4. Tactical Decision-making and Communication

Use of maps for tactical decision-making and the communication of these decisions are tasks performed not only during the mission-planning phase, but also during and after the flight mission. Examples of tactical factors to be considered before flight include the study of fields of fire, trafficability of terrain and required techniques of terrain flight (low-level contour, or NOE). During flight, aviators may be required to communicate their position or the position of targets to infantry units, artillery units, attack helicopters, or high-performance aircraft using coded or uncoded grid coordinates, thrust lines, predesignated code words, or range and bearing from predesignated positions. They must also use the map to determine feasibility of contingency actions in terms of airspeeds, elapsed times, and fuel expenditures required. Maps are also used for intelligence summary; enemy disposition, strength, and associated data are noted on the map during flight, consulted during post-flight debriefing sessions, and employed in pre-flight preparations for subsequent missions.

DIFFICULTIES IN MAP USE

Maps create problems for all users because they do not and cannot represent a true picture of the real word but, instead, are schematic diagrams — stylized, simplified, generalized, and codified presentations of a selected sample of some of the characteristics of the earth's surface. In addition to this general problem, Army aviators must deal with three particular difficulties involving scale, handling, and content.

Scale Problems

Army aviators must use 1:50,000-scale maps because maps in this scale provide the level of detail necessary for maintaining geographic orientation when flying at low altitudes. Unfortunately, maps in this scale are unavailable for large

areas of the earth's surface, and their compilation, revision, and production require very long lead times. As a result, aviators may be forced to use out-of-date 1:50,000-scale maps, or to use 1:250,000 scale maps that provide insufficient detail.

Handling Problems

Maps are cumbersome when used in aircraft cockpits, especially when they must be annotated, refolded, and registered with overlays. Because 1:50,000-scale maps depict only an area of about 23 by 27 kilometers, they must be frequently exchanged for other maps during the course of a mission, resulting in additional handling problems.

Content Problems

Because of the high cost of producing paper maps, virtually all products of the Defense Mapping Agency are designed to serve the needs of several different classes of users. It would be impossible to produce maps with all the information desired by all the potential users without cluttering the maps beyond the point of legibility. Consequently, some compromises must be made in each map's information content, so that each class of user is likely to find the map deficient in some manner. Even a map designed specifically for Army aviators could not present all of the potentially useful topographic information because of the clutter problem, and the cartographer is forced to make judgments regarding the items of information best omitted.

In addition to the topographic content of maps, maps are annotated with tactical information. Aviators have found that annotations written directly on the map must be limited in number if the topographic information is not to be obscured, and that a limited amount of annotation is possible with overlays. Many annotations on a single overlay introduce unacceptable clutter, and attempting to use multiple overlays introduces the problems of positioning errors and lost time in overlay selection and alignment.

THE COMPUTER-GENERATED TOPOGRAPHIC DISPLAY

A computer-generated topographic display system (CGTD) is currently under development by the Advanced Systems Division of the U.S. Army Avionics R&D

Activity. A CGTD system with a cathode ray tube (CRT) display could solve the problems of scale, handling, and content, and could additionally provide dramatic improvements in cartographic support, map-oriented computations, and aviator-map interactions. For example, the computational capability of the CGTD could be used to:

- Change the scale of the displayed map to that optimal for the momentary needs of the aviator.
- Employ small tape cassettes that each store terrain data equivalent to that depicted on 16 1:50,000-scale maps.
- Show the general lay of the land by use of shaded elevation bands to indicate high and low areas.
- Present a shaded "relief map" enhanced by contour lines.
- Display the areas masked from visual or radar observation given known or likely enemy positions.
- Construct oblique, perspective views of terrain to familiarize the aviator with the landforms in the battle area.
- Perform navigational computations pertaining to airspeed, elapsed time, or fuel consumption considerations over a given flight route.
- Interact with a terrain correlation navigation system similar to that used in the cruise missile, which is small, lightweight, accurate in all weather, self-contained, and essentially invulnerable to countermeasures.

In addition to these impressive capabilities, the CGTD could provide operator control over the content of the displayed information. First, the aviator could annotate the cassette with planned course lines, checkpoints, and other data, either at the mission-planning console or in the aircraft. Second, the CGTD would permit the aviator to select any combination of topographic features and tactical information. Thus he could design an optimal map display for mission-planning and in-flight use for any type of terrain or battlefield situation. Aviators could be given control of the classes of information that are displayed (vegetation, hydrography, etc.) and the criteria governing the selection of specific features of a given class to be portrayed (deciduous trees, perennial streams, etc.). Various overlays and annotations could be displayed at will or rapidly deleted to study the underlying topographic data. Because the aviator would control the feature

selection rules, he would also control the density of displayed information and could prevent or eliminate disruptive clutter.

DETERMINATION OF INFORMATION IMPORTANCE

The issue of content selectability, discussed in the preceding subsection, raises questions regarding the range and importance of information items desired by Army aviators. There are two reasons why it is imperative to objectively determine the importance of specific information items. First, all information to be displayed must be digitized in advance. Feature digitization may, in some cases, become costly due to the necessity for manual processing of certain data. Thus, some prioritization of features must be achieved in order to make the cost-effectiveness trade-off in the selection of features to be digitized.

Second, the symbology currently used on paper maps will not, in most cases, be suitable for presentation on a CRT, or on flat-panel electronic displays, because the resolution possible with these devices is only a fraction of that obtainable with the printing process. Not all of the features that will require new symbols are topographic—the annotations used by aviators on maps or map overlays must also be considered. Many of these annotations (showing battlefield situations and other tactical information) will also require redesigned symbols in order to be compatible with the new map display system. Therefore it is important to determine the relative priorities of features so that research on new symbol systems may be conducted in a timely manner.

OBJECTIVES

The general objective of this project was to identify the most important features for presentation by a CGTD designed to meet Army aviation mission requirements. The specific objectives were to:

- Rank features by importance and frequency of use.
- Rank features in importance subdivided by different types of Army aviation units.

- Rank features in importance by the subsets of topographic and annotated features.
- Rank features in importance by the subsets of point, line, and area features.
- Rank features by frequency of their notation in a log, rather than on a map.

METHOD

DESCRIPTION OF THE SAMPLE

One hundred and seven Army aviators participated in this study. These aviators had a collective experience of more than 148,000 hours of helicopter flight — more than 37,000 of these hours accrued during NOE flight.

These 107 aviators represented experience in the full range of helicopters, units and missions of the U.S. Army. Twelve of the participants were instructors from the Career Training Division of the Army Aviation Center at Fort Rucker, Alabama. These aviators were the first to complete the survey and thus also served to evalute the questionnaire itself. Following this pretest, the questionnaires were distributed to selected units of the 101st Airborne Division at Fort Campbell, Kentucky. These units included the following:

229th Attack Helicopter Battalion
2/17 Cavalry Squadron
163rd Aviation Company
159th Assault Support Helicopter Battalion
101st Aviation Battalion
158th Aviation Battalion

Table 1 provides further descriptions of the sample population, including the general types of duty performed; the number of participants from each of the selected units; the average number of flight hours and NOE flight hours of the participants; the percentage of participants experienced in tactical operations center (TOC) procedures; and the percentages of participants qualified in various types of Army rotary-wing aircraft. It is important to recall that all of the figures

TABLE 1
DESCRIPTION OF THE SAMPLE

Duty	ALL AVIATORS	229TH ATK HEL BN	2/17 CAV	163RD AVN CO	159TH ASLT SPT HEL BN	101ST AVN BN	158TH AVN BN	CAREER TNG DIV
	All	Attack	Cavalry	General Support	Assault Support	Assault (Lift)	Assault (Lift)	Instruction
No. Participants	107	18	19	7	24	11	16	12
Average Flight Hours	1,386	1,400	828	1,157	2,295	2,002	2,325	635
Average NOE Hours	350	487	315	243	363	315	489	78
Experienced in TOC (%)	63	61	58	43	71	91	50	58
Aircraft Qualifications (%)								
Scout	40	56	47	71	38	18	13	50
Attack	22	72	47	0	4	0	0	8
Utility/Assault	83	67	84	86	83	100	94	75
Assault Support	32	6	10	0	96	18	31	8

in Table 1 refer to the survey participants and not to the units to which they belong.

DESCRIPTION OF THE QUESTIONNAIRE

A review and analysis was conducted to identify the topographic and tactical features most likely to be useful for NOE aviation tasks. Potentially useful features were gleaned from a variety of sources. The primary sources were existing military topographic maps and map-related FM's, TM's and specifications. In addition, the compilation and coding specifications for existing digital data bases were scrutinized for supplementary features. Finally, features discussed in FM's dealing with tactical planning and operations were added to the list. After duplications and rare features were culled from the list, it was subdivided into 19 categories:

Roads

Railroads

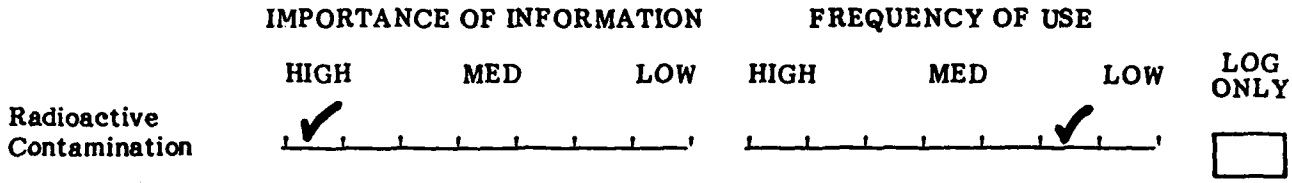
Bridges
Structures
Vertical Features
Large Features
Vegetation Features
Hydrographic Features
Natural Terrain Contour
Man-Made Terrain Contour
Boundaries
Miscellaneous Topographic Features
Friendly Situation
Enemy Situation
Tactical Positions
Tactical Areas
Tactical Lines
Obstacles
Flight Data

In total, 171 features were listed in the questionnaire.

This list of features, while extensive, was certainly not complete. There are obviously too many kinds of features in the real word to consider an all-inclusive digital data base. Nevertheless, a sufficient catalog of features was presented to adequately represent the range of topographic and overlay requirements.

The questionnaire cover page provided a brief description of the CGTD and discussed the purpose of the study. This preliminary information was followed by the instructions:

Because it is not possible to include every conceivable item in the map data base, it is necessary to rate the various items in terms of their value to the Army aviator. A list of approximately 150 items is presented in the following pages. Beside each item are two seven-point rating scales. Please rate each item in terms of its ***importance*** *in NOE missions (for mission-planning and for navigation). Also, rate each item in terms of the* ***frequency*** *of its use. Thus, for example, an item might be rated as very important but infrequently used, as shown in the example below.*



If the information item is one that you would probably ***not*** *want on the map, but* ***would*** *want on a log, kneeboard, or air movement table, check the box labeled "LOG ONLY." For the purposes of this survey, assume that you are operating in a high-threat environment, and that no paper maps are available for the area.*

If this questionnaire has failed to include some topographic features or annotations you believe to be important, please enter and rate them in the spaces provided on the last page.

These instructions are purposefully vague with reference to the meanings of "importance" and "frequency." It is clear that any feature could assume great importance under specific circumstances. In like manner, the anticipated frequency of use of a feature depends upon the specific terrain area and tactical situation. To avoid introducing such biases, the only guidance provided was that the aviator was to assume operations to be in a high-threat environment and paper maps to be unavailable. All other assumptions regarding the importance and frequency of use of features could only be based upon the aviator's own personal experiences and expectations.

RESULTS

CORRELATION OF FREQUENCY AND IMPORTANCE RATINGS

It was apparent during scoring of the questionnaires that aviators tended to rate the importance and usage frequency of features very similarly. Only very rarely were these two ratings substantially different, and these cases were not consistent among aviators. A Pearson product-moment correlation was computed on the frequency and importance ratings (averaged over all 107 aviators), resulting in $r = .98$, an extremely high coefficient. It would appear from these findings that the concepts of importance and frequency of use are too conceptually intertwined

to be easily separated by the aviators. Subsequent data analyses were performed only upon the importance ratings.

ORGANIZATION OF THE IMPORTANCE DATA

The average importance ratings of each feature were calculated for each of the seven participating units. These data are presented in Appendix I. In a few cases there are substantial differences among the ratings of a feature by different units. For example, the attack helicopter and cavalry aviators are much more concerned with bridge load capacity than are assault helicopter aviators. In general, however, the average ratings of features by different units were surprisingly similar. As a result of these findings, and to simplify examination of the data, this section of the report presents the average importance ratings of features by all aviators combined.

Table 2 shows the complete list of features and their average importance ratings, ranked by importance (highest numbers are most important). Table 2 also shows the number of aviators who indicated that they would want the information on a log, kneeboard, or air movement table, rather than on a map or overlay.

Tables 3 and 4 present the same data, separated into topographic feature and annnotated feature rankings. Tables 5 and 6 further classify the topographic and annotated feature rankings into point features, linear features, area features, and descriptive information.

TABLE 2
FEATURE RANKING AND LOG ONLY RESPONSES BY AVIATORS

TOPOGRAPHIC OR ANNOTATED FEATURE	AVERAGE IMPORTANCE RATING	NUMBER OF "LOG ONLY" RESPONSES
AA Weapons (Enemy)	6.94	4
Known Unit Positions (Enemy)	6.87	6
Landforms (Hills, Valleys, etc.)	6.86	0
Wires	6.80	3
FARRP	6.78	8
River	6.76	0
Landing Zone	6.74	5
Power Lines/Pylons	6.68	0
Pickup Zone	6.64	5
NBC Areas	6.60	7
FEBA	6.60	5
Radar Range Fans (Enemy)	6.58	5
Road Location	6.53	0
Target	6.53	8
Objective	6.51	8
Navigation Checkpoint	6.50	7
Release Point	6.49	4
Initial Point	6.49	5
Military Boundaries (DMZ, etc.)	6.49	2
Flight Corridor	6.48	2
Airfield	6.47	1
Suspected Unit Positions (Enemy)	6.46	8
Present Unit Positions (Friendly)	6.45	11
Lake/Pond	6.40	0
Bridge Location	6.40	0
Air Control Point	6.38	5
Attack Position	6.38	10
Artillery Air Corridor	6.32	5
Radio Navigation Aid	6.30	8
RR Track Location	6.29	0
Woodlands	6.29	0
Transmitting Tower	6.27	0
No-Fire Area	6.24	10
Stream	6.24	0
Reservoir	6.21	0
Kill Zone	6.20	9
Unit Size (Enemy)	6.20	20
Dam	6.18	1
Built-up Area	6.17	1
Quarry	6.14	0
Rally/Pickup Point	6.13	8

TABLE 2 (Continued)

TOPOGRAPHIC OR ANNOTATED FEATURE	AVERAGE IMPORTANCE RATING	NUMBER OF "LOG ONLY" RESPONSES
International Boundaries	6.10	4
Air Passage Point	6.10	7
Telephone/Telegraph Lines	6.09	0
Tanks (Enemy)	6.09	10
Canal	6.07	0
Free-Fire Area	6.07	13
Planned Heading	6.06	31
Lookout Tower	6.06	0
Planned Arrival Times	6.05	31
Battle Position	6.02	8
Open Pit Mine	5.99	2
Planned Course	5.99	6
FLOT	5.98	10
Airfield Tower	5.92	1
Emplacements (Obstacles)	5.90	8
Lighthouse	5.87	3
Perennial vs Intermittent (Streams, Ponds, Swamps)	5.83	3
Wind Data	5.83	30
Artillery Reference Point	5.81	11
Water Tower	5.80	0
Road Intersection Shape	5.79	1
Dam Orientation	5.79	2
Paved vs Unpaved Roads	5.79	1
Communication Checkpoint	5.77	10
Holding/Laager Area	5.75	7
Planned Airspeed	5.74	36
Command Post (Friendly)	5.72	10
Time Tick Marks	5.66	12
Assembly Area	5.66	8
Special Equipment (Enemy)	5.65	20
Fields of Fire (Friendly)	5.65	5
Phase Lines	5.63	10
Strip Mine	5.62	2
Cut/Fill	5.62	1
Axis of Advance	5.61	14
Observation Post (Friendly)	5.60	9
Barrier Features	5.58	12
Conspicuous Monument	5.57	3
Swamp/Marsh	5.56	0
Chimney/Smokestack	5.49	0
Power Station	5.46	1
Unit Size (Co, Btn, etc.) (Friendly)	5.44	23
Type of Building (Church, School, Hospital, etc.)	5.43	0

TABLE 2 (Continued)

TOPOGRAPHIC OR ANNOTATED FEATURE	AVERAGE IMPORTANCE RATING	NUMBER OF "LOG ONLY" RESPONSES
Unit Sector Boundaries (Friendly)	5.41	14
Future Unit Positions (Friendly)	5.40	21
Unit Branch (Enemy)	5.38	24
Cemetery	5.38	1
Coordinating Point	5.38	12
Minefields	5.27	13
Tall Building	5.26	1
Storage Tank(s)	5.20	0
Aquaduct/Flume	5.20	3
Falls/Rapids	5.18	3
Orchard/Vineyard	5.17	0
Higher Echelons (Enemy)	5.11	26
Road Overpass/Underpass	5.10	1
Grain Elevator	5.08	1
Stadium	5.07	2
Hairpin Curve	5.06	0
Pipeline	5.04	1
Type of Area (Commercial, Residential, Industrial, etc.)	5.04	4
Tunnel	4.99	1
Outdoor Theater	4.96	4
Average Tree Height	4.94	10
State/Territory Boundary	4.93	7
Divided vs Undivided Roads	4.93	3
BDE Support Area	4.91	17
Town Name	4.90	7
Large Buildings	4.89	0
Number of Tracks (RR)	4.89	3
Cultivated Field	4.88	2
Radar Reflector	4.85	9
Spire/Steeple	4.81	1
Coniferous vs Deciduous Trees	4.79	12
Cooling Tower	4.77	0
Athletic Field	4.76	3
RR Yard	4.74	1
Unit Branch (Friendly)	4.72	32
Percent Canopy Closure	4.68	13
Silo	4.68	0
RR Overpass/Underpass	4.66	1
Causeway	4.66	2
Conveyor/Ski lift, etc.	4.63	2
Offshore Platforms	4.62	7
Blown Bridges	4.62	14
RR Tunnel	4.60	1

TABLE 2 (Continued)

TOPOGRAPHIC OR ANNOTATED FEATURE	AVERAGE IMPORTANCE RATING	NUMBER OF "LOG ONLY" RESPONSES
Windmill/Watermill	4.59	0
Trail/Path	4.59	0
Number of Storage Tanks	4.53	5
RR Station	4.52	1
Microrelief (Boulders, Lava, etc.)	4.50	6
Number of Lanes/Tracks on Bridge	4.50	4
Pier/Jetty/Wharf	4.47	5
Unit Designation (Friendly)	4.46	33
Scrub Brush	4.38	3
Unit Designation (Enemy)	4.35	29
Tank Traps	4.34	15
Special Equipment (Friendly)	4.33	29
RR Siding/Spur	4.30	2
Number of Lanes in Road	4.28	3
Roadblocks	4.26	17
Average River/Stream Width	4.23	11
Higher Echelons (Friendly)	4.18	31
Ford	4.16	3
Seawall	4.03	4
Breakwater	3.99	4
Earthen vs Masonry Dam	3.92	15
Shape of Storage Tanks	3.89	4
Walls/Fences	3.88	2
River Bank Height	3.82	15
Derrick/Crane	3.78	3
House	3.75	1
Ferry	3.75	5
Shaft Mine	3.58	4
Stockyard	3.54	5
Turntable/Roundhouse	3.53	3
Drydock	3.44	7
Barn/Shed	3.41	2
Tailings/Slag Dumps	3.34	5
Bridge Construction Type	3.20	24
Road Name/Number	3.18	7
Bridge Load Capacity	3.02	29
Stream Depth	3.01	19
Parking Areas (Automobile)	2.96	8
Well	2.96	10
Salt Evaporation Pans	2.83	14
Bridge Construction Material	2.71	26
RR Snowshed	2.65	9
Building Construction Material	2.44	25
Diesel vs Electric RR	2.05	14

TABLE 3
TOPOGRAPHIC FEATURE RANKING BY IMPORTANCE

TOPOGRAPHIC FEATURE	AVERAGE IMPORTANCE RATING BY AVIATORS
Landforms (Hills, Valleys, etc.)	6.86
Wires	6.80
River	6.76
Power Lines/Pylons	6.68
Road Location	6.53
Airfield	6.47
Lake/Pond	6.40
Bridge Location	6.40
RR Track Location	6.29
Woodlands	6.29
Transmitting Tower	6.27
Stream	6.24
Reservoir	6.21
Dam	6.18
Built-up Area	6.17
Quarry	6.14
International Boundaries	6.10
Telephone/Telegraph Lines	6.09
Canal	6.07
Lookout Tower	6.06
Open Pit Mine	5.99
Airfield Tower	5.92
Lighthouse	5.87
Perennial vs Intermittent (Streams, Ponds, Swamps)	5.83
Water Tower	5.80
Road Intersection Shape	5.79
Dam Orientation	5.79
Paved vs Unpaved Roads	5.79
Strip Mine	5.62
Cut/Fill	5.62
Barrier Features	5.58
Conspicuous Monument	5.57
Swamp/Marsh	5.56
Chimney/Smokestack	5.49
Power Station	5.46
Type of Building (Church, School, Hospital, etc.)	5.43
Cemetery	5.38
Tall Building	5.26
Storage Tank(s)	5.20
Aquaduct/Flume	5.20
Falls/Rapids	5.18
Orchard/Vineyard	5.17
Road Overpass/Underpass	5.10
Grain Elevator	5.08

Table 3 (Continued)

TOPOGRAPHIC FEATURE	AVERAGE IMPORTANCE RATING BY AVIATORS
Stadium	5.07
Hairpin Curve	5.06
Pipeline	5.04
Type of Area (Commercial, Residential, Industrial, etc.)	5.04
Tunnel	4.99
Outdoor Theater	4.96
Average Tree Height	4.94
State/Territory Boundary	4.93
Divided vs Undivided Roads	4.93
Town Name	4.90
Large Buildings	4.89
Number of Tracks (RR)	4.89
Cultivated Field	4.88
Radar Reflector	4.85
Spire/Steeple	4.81
Coniferous vs Deciduous Trees	4.79
Cooling Tower	4.77
Athletic Field	4.76
RR Yard	4.74
Percent Canopy Closure	4.68
Silo	4.68
RR Overpass/Underpass	4.66
Causeway	4.66
Conveyor/Ski lift, etc.	4.63
Offshore Platforms	4.62
RR Tunnel	4.60
Windmill/Watermill	4.59
Trail/Path	4.59
Number of Storage Tanks	4.53
RR Station	4.52
Microrelief (Boulders, Lava, etc.)	4.50
Number of Lanes/Tracks on Bridge	4.50
Pier/Jetty/Wharf	4.47
Scrub Brush	4.38
RR Siding/Spur	4.30
Number of Lanes in Road	4.28
Average River/Stream Width	4.23
Higher Echelons (Friendly)	4.18
Ford	4.16
Seawall	4.03
Breakwater	3.99
Earthen vs Masonry Dam	3.92
Shape of Storage Tanks	3.89
Walls/Fences	3.88
River Bank Height	3.82

TABLE 3 (Continued)

TOPOGRAPHIC FEATURE	AVERAGE IMPORTANCE RATING BY AVIATORS
Derrick/Crane	3.78
House	3.75
Ferry	3.75
Shaft Mine	3.58
Stockyard	3.54
Turntable/Roundhouse	3.53
Drydock	3.44
Barn/Shed	3.41
Tailings/Slag Dumps	3.34
Bridge Construction Type	3.20
Road Name/Number	3.18
Bridge Load Capacity	3.02
Stream Depth	3.01
Parking Areas (Automobile)	2.96
Well	2.96
Salt Evaporation Pans	2.83
Bridge Construction Material	2.71
RR Snowshed	2.65
Building Construction Material	2.44
Diesel vs Electric RR	2.05

TABLE 4
ANNOTATED FEATURE RANKING BY IMPORTANCE

ANNOTATED FEATURE	AVERAGE IMPORTANCE RATING BY AVIATORS
AA Weapons (Enemy)	6.94
Known Unit Positions (Enemy)	6.87
Wires	6.80
FARRP	6.78
Landing Zone	6.74
Pickup Zone	6.64
NBC Areas	6.60
FEBA	6.60
Radar Range Fans (Enemy)	6.58
Target	6.53
Objective	6.51
Navigation Checkpoint	6.50
Release Point	6.49
Initial Point	6.49
Military Boundaries (DMZ, etc.)	6.49
Flight Corridor	6.48
Suspected Unit Positions (Enemy)	6.46
Present Unit Positions (Friendly)	6.45
Air Control Point	6.38
Attack Position	6.38
Artillery Air Corridor	6.32
Radio Navigation Aid	6.30
No-Fire Area	6.24
Kill Zone	6.20
Unit Size (Enemy)	6.20
Rally/Pickup Point	6.13
Air Passage Point	6.10
Tanks (Enemy)	6.09
Free-Fire Area	6.07
Planned Heading	6.06
Planned Arrival Times	6.05
Battle Position	6.02
Planned Course	5.99
FLOT	5.98
Emplacements (Obstacles)	5.90
Wind Data	5.83
Artillery Reference Point	5.81
Communication Checkpoint	5.77
Holding/Laager Area	5.75
Planned Airspeed	5.74
Command Post (Friendly)	5.72
Time Tick Marks	5.66
Assembly Area	5.66

TABLE 4 (Continued)

ANNOTATED FEATURE	AVERAGE IMPORTANCE RATING BY AVIATORS
Special Equipment (Enemy)	5.65
Fields of Fire (Friendly)	5.65
Phase Lines	5.63
Axis of Advance	5.61
Observation Post (Friendly)	5.60
Unit Size (Co, Btn, etc.) (Friendly)	5.44
Unit Sector Boundaries (Friendly)	5.41
Future Unit Positions (Friendly)	5.40
Unit Branch (Enemy)	5.38
Coordinating Point	5.38
Minefields	5.27
Higher Echelons (Enemy)	5.11
BDE Support Area	4.91
Unit Branch (Friendly)	4.72
Blown Bridges	4.62
Unit Designation	4.46
Unit Designation (Enemy)	4.35
Tank Traps	4.34
Special Equipment (Friendly)	4.33
Roadblocks	4.26
Higher Echelons (Friendly)	4.18

TABLE 5
TOPOGRAPHIC FEATURE RANKING BY IMPORTANCE SUBDIVIDED BY TYPE

TOPOGRAPHIC FEATURE	AVERAGE IMPORTANCE RATING BY AVIATORS
Point Features	
Airfield	6.47
Bridge Location	6.40
Transmitting Tower	6.27
Reservoir	6.21
Dam	6.18
Quarry	6.14
Lookout Tower	6.06
Open Pit Mine	5.99
Airfield Tower	5.92
Lighthouse	5.87
Water Tower	5.80
Strip Mine	5.62
Conspicuous Monument	5.57
Chimney/Smokestack	5.49
Power Station	5.46
Type of Building (Church, School, Hospital, etc.)	5.43
Cemetery	5.38
Tall Building	5.26
Storage Tank(s)	5.20
Falls/Rapids	5.18
Road Overpass/Underpass	5.10
Grain Elevator	5.08
Stadium	5.07
Outdoor Theater	4.96
Large Buildings	4.89
Radar Reflector	4.85
Spire/Steeple	4.81
Cooling Tower	4.77
Athletic Field	4.76
RR Yard	4.74
Silo	4.68
RR Overpass/Underpass	4.66
Offshore Platforms	4.62
Windmill/Watermill	4.59
RR Station	4.52
Pier/Jetty/Wharf	4.47
Ford	4.16
Seawall	4.03
Breakwater	3.99

TABLE 5 (Continued)

TOPOGRAPHIC FEATURE	AVERAGE IMPORTANCE RATING BY AVIATORS
Point Features (Continued)	
Derrick/Crane	3.78
House	3.75
Ferry	3.75
Shaft Mine	3.58
Stockyard	3.54
Turntable/Roundhouse	3.53
Drydock	3.44
Barn/Shed	3.41
Tailings/Slag Dumps	3.34
Well	2.96
RR Snowshed	2.65
Linear Features	
Landforms (Hills, Valleys, etc.)	6.86
Wires	6.80
River	6.76
Power Lines/Pylons	6.68
Road Location	6.53
Airfield	6.47
RR Track Location	6.29
Stream	6.24
Dam	6.18
International Boundaries	6.10
Telephone/Telegraph Lines	6.09
Canal	6.07
Road Intersection Shape	5.79
Dam Orientation	5.79
Cut/Fill	5.62
Barrier Features	5.58
Aquaduct/Flume	5.20
Hairpin Curve	5.06
Pipeline	5.04
Tunnel	4.99
State/Territory Bounday	4.93
Causeway	4.66
Conveyor/Ski Lift, etc.	4.63
RR Tunnel	4.60
Trail/Path	4.59
Pier/Jetty/Wharf	4.47
RR Siding/Spur	4.30

TABLE 5 (Continued)

TOPOGRAPHIC FEATURE	AVERAGE IMPORTANCE RATING BY AVIATORS
Linear Features (Continued)	
Seawall	4.03
Breakwater	3.99
Walls/Fences	3.88
Area Features	
Lake/Pond	6.40
Woodlands	6.29
Built-up Area	6.17
Swamp/Marsh	5.56
Orchard/Vineyard	5.17
Cultivated Field	4.88
Microrelief (Boulders, Lava, etc.)	4.50
Scrub Brush	4.38
Parking Areas (Automobile)	2.96
Salt Evaporation Pans	2.83
Descriptive Information	
Perennial vs Intermittent (Streams, Ponds, Swamps)	5.83
Paved vs Unpaved Roads	5.79
Type of Area (Commercial, Residential, Industrial, etc.)	5.04
Average Tree Height	4.94
Divided vs Undivided Roads	4.93
Town Name	4.93
Number of Tracks (RR)	4.89
Coniferous vs Deciduous Trees	4.79
Percent Canopy Closure	4.68
Number of Storage Tanks	4.53
Number of Lanes/Tracks on Bridge	4.50
Number of Lanes in Road	4.28
Average River/Stream Width	4.23
Higher Echelons (Friendly)	4.18
Earthen vs Masonry Dam	3.92
Shape of Storage Tanks	3.89
River Bank Height	3.82
Bridge Construction Type	3.20
Road Name/Number	3.18
Bridge Load Capacity	3.02
Stream Depth	3.01
Bridge Construction Material	2.71
Building Construction Material	2.44
Diesel vs Electric RR	2.05

TABLE 6
ANNOTATED FEATURE RANKING BY IMPORTANCE SUBDIVIDED BY TYPE

ANNOTATED FEATURE	AVERAGE IMPORTANCE RATING BY AVIATORS
Point Features	
AA Weapons (Enemy)	6.94
Known Unit Positions (Enemy)	6.87
FARRP	6.78
Landing Zone	6.74
Pickup Zone	6.64
NBC Areas	6.60
Target	6.53
Objective	6.51
Navigation Checkpoint	6.50
Release Point	6.49
Initial Point	6.49
Suspected Unit Positions (Enemy)	6.46
Present Unit Positions (Friendly)	6.45
Air Control Point	6.38
Attack Position	6.38
Radio Navigation Aid	6.30
Rally/Pickup Point	6.13
Air Passage Point	6.10
Tanks (Enemy)	6.09
Battle Position	6.02
Emplacements (Obstacles)	5.90
Artillery Reference Point	5.81
Communication Checkpoint	5.77
Holding/Laager Area	5.75
Command Post (Friendly)	5.72
Observation Post (Friendly)	5.60
Future Unit Positions (Friendly)	5.40
Coordinating Point	5.38
Roadblocks	4.26
Linear Features	
Wires	6.80
FEBA	6.60
Radar Range Fans (Enemy)	6.58
Military Boundaries (DMZ, etc.)	6.49
Flight Corridor	6.48
Artillery Air Corridor	6.32

TABLE 6 (Continued)

ANNOTATED FEATURE	AVERAGE IMPORTANCE RATING BY AVIATORS
Linear Symbols (Continued)	
Planned Course	5.99
FLOT	5.98
Fields of Fire (Friendly)	5.65
Phase Lines	5.63
Axis of Advance	5.61
Unit Sector Boundaries	5.41
Tank Traps	4.34
Area Symbols	
NBC Areas	6.60
Radar Range Fans (Enemy)	6.58
Flight Corridor	6.48
Artillery Air Corridor	6.32
No-Fire Area	6.24
Kill Zone	6.20
Free-Fire Area	6.07
Holding/Laager Area	5.75
Assembly Area	5.66
Fields of Fire (Friendly)	5.65
Minefields	5.27
BDE Support Area	4.91
Tank Traps	4.34
Descriptive Information	
Unit Size (Enemy)	6.20
Planned Heading	6.06
Planned Arrival Times	6.05
Wind Data	5.83
Artillery Reference Point	5.81
Planned Airspeed	5.74
Time Tick Marks	5.66
Special Equipment (Enemy)	5.65
Unit Size (Co, Btn, etc.) (Friendly)	5.44
Unit Branch (Enemy)	5.38
Higher Echelons (Enemy)	5.11
Unit Branch (Friendly)	4.72
Blow Bridges	4.62
Unit Designation	4.46
Unit Designation (Enemy)	4.35
Special Equiment (Friendly)	4.33
Higher Echelons (Friendly)	4.18

DISCUSSION

It is interesting to note that nearly the entire range of the seven-point scale was used by the aviators in their judgments of feature importance. The fact that extreme values are reflected even in the averaged scores suggests that the participants were conscientious in their evaluations of feature importance, and that there was good consistency among the judgments. The distribution of scores is somewhat skewed, with more features rated high than low in importance. Such a distribution is to be expected since features were chosen for inclusion in the questionnaire based upon their probable utility to the Army aviator.

The participants often disagreed on the features that are best left off the map and recorded in a log, kneeboard or air movement table. The majority preferred nearly all of the information to be shown on the map or overlay. Others indicated that the map should be kept unmarked to the greatest extent possible, and that all descriptive or tactical information should be recorded in the flight log or other such device. About one-third of the participants agreed that flight data and friendly or enemy unit information should be kept primarily in a log. These findings will be discussed in greater detail later in this section of the report.

It would seem that, in general, the annotated tactical features are rated as more important than many of the topographic features. Fifty percent of the annotated features received average ratings greater than 6.0, while only 18.5% of the topographic features received such ratings.

Such comparisons, however, may be misleading. Annotated information is always important—otherwise it would not be placed on the map or overlay. Topographic features may or may not assume great importance depending upon the type of terrain and the tactical situation. Furthermore, the percentages would change greatly if all the various types of landforms (hills, valleys, ridges, draws, etc.) were evaluated separately instead of together. It is more useful to examine the results in terms of the 19 categories of features presented in the questionnaire.

Roads

The locations of roads were rated as very important to the aviators. The shapes of intersections and whether or not the roads are paved were also rated as

high in importance. Other road characteristics are of moderate importance. Very few aviators indicated that road information should be shown in a log.

Railroads

Location of railroad tracks were rated as important. Other characteristics were rated as only moderate in importance. Few aviators would log any of this information except whether the railroad was diesel or electric.

Bridges

Only bridge location was rated high in importance, but many of the aviators would record bridge capacity, construction type, and construction material in a log if such data were available.

Structure

Built-up areas were rated as very important. Type of area, conspicuous monuments, and type of buildings were somewhat less important, and other characteristics or types were of low to moderate importance. About one-fourth of the aviators would note building construction material in a log, if known.

Vertical Features

Most vertical features (various types of towers) were rated as fairly high in importance because of their utility in navigation during NOE flight. Very few aviators indicated that such features should be noted in logs.

Large Features

Dams and airfields were rated as very high in importance. Cemetaries, power stations, and dam orientation received moderately high ratings. Some aviators noted that dam construction material (earthen vs masonry) should be noted in a log.

Vegetation Features

The locations of woodlands were rated as very high in importance because of their value in maintaining cover and concealment. Other vegetation features were of moderate importance. Some aviators indicated that percent canopy closure and coniferous vs. deciduous should be kept in a log.

Hydrographic Features

Many hydrographic features were considered to be high in importance by the aviators — rivers, streams, lakes, ponds, swamps, marshes, canals, and reservoirs and the perennial/intermittent discrimination all received high ratings. A moderate proportion of the aviators would include river bank height, stream depth, and average width in a log.

Natural Terrain Contours

As anticipated, landforms were rated as very high in importance. Log entries were never suggested for these features, although a few of the aviators would record microrelief in a log.

Man-made Terrain Contours

Relatively large man-made contours, including cuts, fills, quarries, open pit mines, and strip mines were rated high in importance. Log entries were rarely suggested for use with these features.

Boundaries

Military and international boundaries were rated as high in importance. Log entries were very seldom selected as applicable for boundaries.

Miscellaneous Topographic Features

Powerlines/pylons and telephone/telegraph lines were rated high in importance (primarily because they are hazards to NOE flight). Other features received low to moderate ratings. Some of the aviators indicated that wells and radar reflectors should be noted in a log; otherwise log entries were rarely suggested.

Friendly Situation

The most important features of the friendly situation are present unit positions. Unit sizes and future unit positions were rated moderately high in importance. Other information (branch, unit designation, higher echelons, and special equipment) were only rated as moderately important. It is especially interesting to note that a relatively great number of aviators would enter all but the unit position in a log rather than on the map. Such findings are important

because military unit symbols can become extremely complex and cluttered when used to convey situation data in great detail.

Enemy Situation

The aviators ranked enemy anti-aircraft weapons as the most important data of all, followed by known enemy locations. Suspected enemy positions, enemy unit size, tanks, and radar range fans were also rated high in importance. Other data such as unit branch, designation, and higher echelons was ranked as moderately important. The "log only" responses were similar to those pertaining to the friendly situation — many indicated that data other than unit positions or suspected positions should be recorded on a log or kneeboard rather than upon the map.

Tactial Positions

Nearly all of the tactical positions (such as landing zones, FARRPs, targets, etc.) were rated as very high in importance. With few exceptions, logging these kinds of features was seldom selected as the proper way of recording such data.

Tactical Areas

Most tactical areas (such as NBC areas or flight corridors) were rated as high in importance. Only very few aviators indicated that the areas should be logged rather than noted on a map or overlay.

Tactical Lines

Tactical lines (such as phase lines, the FEBA, and the FLOT) were usually rated high in importance. Only a small number of aviators would attempt to record them in a log, although the unit sector boundaries and axis of advance were exceptions. Often, topographic features (roads, rivers, etc.) are used as tactical lines and thus could be logged rather than traced on the map.

Obstacles

The most important obstacles are wires—they are rated fourth in importance among all features. Other obstacles are only of medium to moderate importance. Minefields, tank traps, blown bridges, and roadblocks were often noted as data to be logged rather than written on a map.

Flight Data

Not surprisingly, flight data was rated as moderately high to high in importance, but a relatively large percentage of the aviators indicated that such data (planned airspeeds, headings, arrival times, etc.) should be entered on a flight log, kneeboard, or air movement table, rather than upon the map itself.

Additional Features Suggested by Aviators

Only 14 features were added to the questionnaire by the aviators, and none of these was noted by more than one aviator. Although it may be assumed that the participants were anxious to conclude their ratings, this low number of additions is still encouraging evidence that all of the most important features were included in the questionnaire.

APPENDIX I

AVERAGE IMPORTANCE RATINGS OF EACH FEATURE FOR EACH OF THE PARTICIPATING UNITS

	ALL AVIATORS	229TH ATK HEL BN	2/17 CAV	163RD AVN CO	159TH ASLT SPT HEL BN	101ST AVN BN	158TH AVN BN	CAREER TNG DIV
ROADS								
Road Location	6.53	6.50	6.63	6.14	6.39	6.91	6.50	6.58
Show if Divided or Undivided	4.93	5.06	4.44	5.71	5.27	5.36	4.81	4.17
Show if Paved or Unpaved	5.79	5.72	5.79	6.14	6.26	5.73	5.75	4.92
Number of Lanes	4.28	3.94	4.50	4.86	4.52	4.55	4.23	3.50
Road Name/Number	3.18	3.41	3.29	3.86	3.04	2.82	2.87	3.25
Trail/Path	4.59	4.39	5.05	4.43	4.83	4.45	4.13	4.58
Intersection Shape	5.79	5.50	6.11	5.12	6.17	6.64	5.56	4.91
Parking Areas	2.96	2.94	3.63	1.71	2.87	3.40	2.8[illegible]	2.80
Hairpin Curve	5.06	5.33	5.05	4.71	5.14	5.73	4.38	5.00
Overpass/Underpass	5.10	5.00	5.00	4.71	5.77	5.45	4.56	4.83
Tunnel	4.99	5.00	5.21	4.29	5.52	5.36	4.19	4.75
Causeway	4.66	4.76	4.42	5.71	4.69	5.00	4.19	4.55
Ferry	3.75	4.50	4.17	3.43	3.30	4.09	3.31	3.17
Ford	4.16	4.72	5.68	3.50	3.74	3.82	3.73	3.67
RAILROADS								
Track Location	6.29	6.22	6.37	6.43	6.58	6.91	5.75	5.75
Number of Tracks	4.89	5.06	4.21	4.71	5.33	6.00	4.20	4.73
Siding/Spur	4.30	4.22	3.83	4.33	4.65	4.55	4.19	4.33
Show if Diesel or Electric	2.05	2.29	1.69	1.83	2.10	2.55	2.19	1.55

	ALL AVIATORS	229TH ATK HEL BN	2/17 CAV	163RD AVN CO	159TH ASLT SPT HEL BN	101ST AVN BN	158TH AVN BN	CAREER TNG DIV
RR Yard	4.74	5.11	4.72	5.00	5.04	5.09	3.75	4.08
RR Station	4.52	4.78	4.89	4.71	4.67	4.73	3.75	4.17
Turntable/Roundhouse	3.53	4.00	3.13	3.71	3.61	4.09	3.56	2.58
Overpass/Underpass	4.66	4.89	4.44	4.29	4.92	5.18	4.19	4.50
RR Tunnel	4.60	4.78	4.44	4.43	5.29	4.36	3.81	4.58
RR Snowshed	2.65	3.00	2.94	1.67	2.90	2.64	2.25	2.33
BRIDGES								
Bridge Location	6.40	6.67	6.68	6.29	6.63	6.55	5.94	6.00
Number of Lanes/Tracks	4.50	5.18	4.76	4.29	3.96	5.00	3.94	4.60
Load Capacity	3.02	4.13	4.00	2.71	2.33	2.10	1.75	3.30
Construction Type	3.20	3.19	4.13	3.71	2.94	2.56	2.36	3.60
Construction Material	2.71	3.00	3.43	3.14	2.89	1.89	1.85	2.44
STRUCTURES								
Built-up Area	6.17	5.72	6.26	6.00	6.33	6.27	6.38	6.08
Type of Area (Commercial, Residential, Industrial, Etc.)	5.04	4.76	5.37	4.86	4.95	5.00	5.00	5.27
Town Name	4.90	5.11	5.06	4.86	4.91	4.09	4.67	5.42
House	3.75	3.44	4.11	3.14	3.96	4.09	4.00	2.92
Large Buildings	4.89	4.39	4.26	6.00	5.38	5.36	4.75	4.75
Type of Building (Church, School, Hospital, Etc.)	5.43	5.67	6.26	6.00	5.21	6.36	4.81	5.42
Building Construction Material	2.44	2.63	3.00	2.57	2.12	2.00	2.50	2.20

	ALL AVIATORS	229TH ATK HEL BN	2/17 CAV	163RD AVN CO	159TH ASLT SPT HEL BN	101ST AVN BN	158TH AVN BN	CAREER TNG DIV
Conspicuous Monument	5.57	5.83	5.26	6.00	5.83	6.00	5.27	4.82
Barn/Shed	3.41	3.56	3.89	3.71	3.38	3.09	3.50	2.50
Silo	4.68	5.00	5.53	4.86	4.63	5.18	3.75	3.55
Windmill/Watermill	4.59	5.11	5.16	3.43	4.75	4.91	4.25	3.42
Stockyard	3.54	3.61	3.82	3.14	3.74	3.91	3.13	2.83
VERTICAL FEATURES								
Lighthouse	5.87	6.11	5.56	4.86	6.13	6.27	5.94	5.55
Lookout Tower	6.06	6.17	6.37	6.00	6.25	6.36	5.63	5.33
Transmitting Tower	6.27	6.17	6.32	6.14	6.38	6.64	6.00	6.25
Grain Elevator	5.08	5.44	5.58	4.43	5.17	5.09	4.44	4.73
Derrick/Crane	3.78	3.67	4.17	2.29	4.09	4.27	3.63	3.40
Chimney/Smokestack	5.49	5.12	5.68	5.43	6.13	5.64	5.00	5.00
Cooling Tower	4.77	4.39	4.89	4.71	5.13	4.91	4.40	4.83
Airfield Tower	5.92	5.61	6.16	6.43	6.21	5.64	5.38	6.08
Water Tower	5.80	5.67	6.11	5.86	5.92	6.09	5.38	5.58
Tall Building	5.26	5.17	5.11	5.14	5.38	5.55	5.13	5.45
Spire/Steeple	4.81	5.22	4.79	4.30	4.92	5.00	4.31	5.00
LARGE FEATURES								
Cemetery	5.38	5.83	5.63	5.71	5.13	5.73	4.94	4.82
Athletic Field	4.76	5.06	4.89	4.71	4.79	5.45	4.69	3.30

	ALL AVIATORS	229TH ATK HEL BN	2/17 CAV	163RD AVN CO	159TH ASLT SPT HEL BN	101ST AVN BN	158TH AVN BN	CAREER TNG DIV
Stadium	5.07	5.18	5.11	4.86	4.96	5.55	5.25	4.45
Outdoor Theater	4.96	4.82	5.28	4.86	4.96	5.55	4.94	4.10
Dam	6.18	6.65	5.67	6.57	6.42	6.27	6.25	5.42
Show if Earthen or Masonry Dam	3.92	4.06	3.88	3.71	4.15	3.73	3.93	3.50
Show Dam Orientation	5.79	5.61	6.32	5.86	5.58	5.64	6.13	5.27
Power Station	5.46	6.17	5.84	5.29	5.33	5.36	5.13	4.67
Airfield	6.47	6.61	6.58	6.71	6.46	6.91	6.27	5.83
Breakwater	3.99	4.00	3.89	3.29	3.92	4.70	4.69	3.09
Pier/Jetty/Wharf	4.47	4.67	4.33	3.71	5.04	5.00	4.25	3.40
Seawall	4.03	4.39	3.78	3.86	4.43	3.90	4.06	3.18
Drydock	3.44	3.50	3.56	2.43	3.68	3.30	3.50	3.33
Salt Evaporation Pans	2.83	3.13	2.82	2.14	2.90	2.70	3.06	2.45
Offshore Platforms	4.62	4.33	4.05	4.71	4.57	4.91	5.38	4.67
VEGETATION								
Woodlands	6.29	5.94	6.68	6.71	6.29	6.00	6.31	6.17
Show if Coniferous or Deciduous	4.79	4.82	5.50	5.14	4.26	4.70	4.69	4.44
Percent Canopy Closure	4.68	4.75	5.16	4.83	4.32	3.40	5.14	5.00
Average Tree Height	4.94	4.81	4.89	4.43	4.57	5.27	5.13	5.89
Scrub Brush	4.38	4.12	4.84	3.86	4.46	4.27	4.31	4.33
Cultivated Field	4.88	4.94	5.89	4.00	4.26	5.27	4.75	4.67
Orchard/Vineyard	5.17	5.44	5.84	4.86	4.46	5.45	5.25	4.92

	ALL AVIATORS	229TH ATK HEL BN	2/17 CAV	163RD AVN CO	159TH ASLT SPT HEL BN	101ST AVN BN	158TH AVN BN	CAREER TNG DIV
HYDROGRAPHIC FEATURES								
River	6.76	6.61	7.00	6.86	6.67	6.73	6.75	6.75
River Bank Height	3.82	3.63	3.94	3.57	3.75	3.20	4.38	4.00
Stream	6.24	6.06	6.74	5.43	6.25	6.55	5.94	6.33
Stream Depth	3.01	3.44	3.24	3.00	2.47	2.33	2.93	3.78
Average Width	4.23	4.06	4.47	4.00	4.52	3.36	3.87	5.10
Falls/Rapids	5.18	5.44	5.58	4.86	5.00	5.55	4.94	4.67
Lake/Pond	6.40	6.00	6.74	6.43	6.38	6.27	6.31	6.75
Swamp/Marsh	5.56	5.50	5.68	5.57	5.63	5.45	5.31	5.92
Show if Perennial or Intermittent (Streams, Ponds, Swamps)	5.83	5.89	6.39	6.00	5.83	5.40	5.69	5.20
Canal	6.07	6.22	6.42	5.29	5.92	6.00	6.00	6.18
Reservoir	6.21	6.33	6.37	6.29	6.25	6.18	6.00	5.91
Aquaduct/Flume	5.20	5.11	5.00	5.00	5.17	5.80	5.33	5.11
NATURAL TERRAIN CONTOUR								
Landforms (Hills, Valleys, Etc.)	6.86	6.89	7.00	6.71	6.79	6.91	6.81	6.82
Microrelief (Boulders, Lava, Etc.)	4.50	4.47	4.94	4.00	4.29	4.45	4.50	4.56

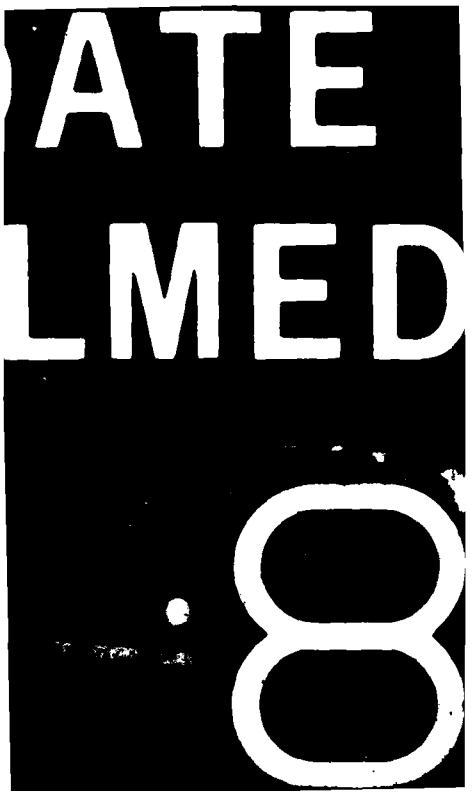
	ALL AVIATORS	229TH ATK HEL BN	2/17 CAV	163RD AVN CO	159TH ASLT SPT HEL BN	101ST AVN BN	158TH AVN BN	CAREER TNG DIV
MAN-MADE TERRAIN CONTOUR								
Cut/Fill	5.62	5.44	6.11	5.43	5.71	5.82	5.47	4.90
Quarry	6.14	6.33	6.11	6.00	5.96	6.18	6.75	5.45
Open Pit Mine	5.99	6.39	6.05	5.86	5.91	6.18	5.81	5.50
Strip Mine	5.62	6.06	5.74	5.86	5.43	5.91	5.56	4.60
Shaft Mine	3.58	3.61	3.83	3.57	3.77	3.82	3.56	2.55
Tailings/Slag Dumps	3.34	3.67	3.50	3.14	3.19	3.60	3.19	3.00
BOUNDARIES								
Military (DMZ, Etc.)	6.49	6.50	6.37	6.00	6.52	6.45	6.56	6.82
State/Territory	4.93	4.25	5.47	4.43	5.05	4.40	4.56	6.09
International	6.10	5.44	6.74	4.86	6.09	5.82	6.44	6.55
MISCELLANEOUS FEATURES								
Power Lines/Pylons	6.68	6.56	6.84	6.71	6.54	7.00	6.75	6.50
Telephone/Telegraph Lines	6.09	6.28	6.42	6.14	5.67	6.18	6.00	6.18
Pipeline	5.04	5.06	4.95	5.71	5.39	5.45	4.25	4.75
Conveyor/Ski Lift, Etc.	4.63	4.47	4.56	5.00	4.67	5.36	4.13	4.64
Walls/Fences	3.88	4.06	4.06	4.43	3.57	4.18	3.56	3.75
Storage Tank(s)	5.20	4.89	4.89	5.29	5.75	5.73	4.69	4.75
Number of Tanks	4.53	4.67	4.61	4.57	4.39	5.64	4.13	3.75

	ALL AVIATORS	229TH ATK HEL BN	2/17 CAV	163RD AVN CO	159TH ASLT SPT HEL BN	101ST AVN BN	158TH AVN BN	CAREER TNG DIV
Shape of Tanks	3.89	4.06	3.72	3.71	3.83	4.73	3.44	4.00
Well	2.96	2.56	3.22	2.71	3.21	3.27	2.94	2.50
Radar Reflector	4.85	4.69	4.82	4.71	5.25	5.36	4.81	3.89
FRIENDLY SITUATION								
Present Unit Positions	6.45	6.88	6.63	7.00	6.04	6.55	6.13	6.64
Future Unit Positions	5.40	4.80	5.18	6.00	5.35	5.60	5.47	6.18
Unit Size (Co, Btn, Etc.)	5.44	5.69	5.94	5.00	5.21	5.64	4.69	5.80
Unit Branch	4.72	5.08	4.93	3.67	5.25	4.00	4.50	4.50
Unit Designation	4.46	4.85	4.93	5.33	3.88	4.20	3.56	5.78
Higher Echelons	4.18	4.15	4.54	5.00	3.94	4.00	3.81	4.70
Special Equipment	4.33	4.67	4.33	5.33	3.67	5.18	4.47	3.44
ENEMY SITUATION								
Known Unit Positions	6.87	7.00	6.89	7.00	6.92	6.73	6.81	6.75
Suspected Unit Positions	6.46	6.67	6.59	6.75	6.48	6.09	6.25	6.42
Unit Size	6.20	6.35	6.36	6.75	6.38	6.09	5.50	6.36
Unit Branch	5.38	5.36	5.31	6.25	5.42	5.10	4.75	6.27
Unit Designation	4.35	4.77	4.79	4.75	4.24	3.60	3.73	5.00
Higher Echelons	5.11	5.57	5.38	6.40	4.72	4.73	4.80	5.09
Special Equipment	5.65	6.20	5.38	6.40	5.32	5.55	5.79	5.45
AA Weapons	6.94	6.94	6.94	7.00	7.00	7.00	6.81	6.92

	ALL AVIATORS	229TH ATK HEL BN	2/17 CAV	163RD AVN CO	159TH ASLT SPT HEL BN	101ST AVN BN	158TH AVN BN	CAREER TNG DIV
Radar Range Fans	6.58	6.47	6.32	7.00	6.71	6.91	6.69	6.42
Tanks	6.09	6.33	6.06	5.50	6.09	6.36	6.07	5.92
POSITIONS								
Initial Point	6.49	6.35	6.61	6.00	6.30	6.73	6.75	6.50
Pickup Zone	6.64	6.06	6.56	6.67	6.83	6.91	6.75	6.83
Landing Zone	6.74	6.31	6.67	6.83	6.88	6.91	6.81	6.83
Release Point	6.49	6.31	6.47	6.30	6.33	6.73	6.63	6.75
Attack Position	6.38	6.82	6.50	6.70	6.25	6.27	5.81	6.50
Command Post	5.72	5.19	5.89	6.60	5.67	6.00	5.31	6.17
Air Control Point	6.38	6.61	6.39	6.17	6.43	5.73	6.31	6.67
FARRP	6.78	6.94	6.67	6.80	6.78	6.82	6.63	6.92
Objective	6.51	6.75	6.67	6.50	6.33	6.09	6.44	6.82
Navigation Checkpoint	6.50	6.50	6.67	7.00	6.33	6.09	6.50	6.75
Communication Checkpoint	5.77	5.56	5.56	6.40	5.91	5.09	5.94	6.25
Target	6.53	6.71	6.50	6.75	6.26	6.55	6.50	6.82
Artillery Reference Point	5.81	5.53	5.94	6.60	5.81	5.64	5.75	5.90
Rally/Pickup Point	6.13	5.86	6.11	6.33	6.23	6.27	6.00	6.25
Battle Position	6.02	6.06	6.37	6.50	5.57	6.45	5.69	6.00
Observation Post	5.60	5.47	5.89	5.50	5.50	5.45	5.31	6.08
Coordinating Point	5.38	5.00	5.44	6.40	5.80	5.00	4.75	5.83
Air Passage Point	6.10	6.28	6.50	6.83	5.86	6.09	5.44	6.17
Radio Navigation Aid	6.30	5.93	6.67	6.67	6.50	6.55	6.06	5.67

	ALL AVIATORS	229TH ATK HEL BN	2/17 CAV	163RD AVN CO	159TH ASLT SPT HEL BN	101ST AVN BN	158TH AVN BN	CAREER TNG DIV
AREAS								
Assembly Area	5.66	5.71	6.56	5.00	5.05	6.00	5.13	5.92
Holding/Laager Area	5.75	5.94	6.17	6.00	5.24	6.18	5.38	5.75
NBC Areas	6.60	6.61	6.71	6.80	6.50	6.82	6.38	6.64
BDE Support Area	4.91	5.00	4.71	6.00	5.00	4.73	4.50	5.18
Free-Fire Area	6.07	6.47	6.24	6.33	6.19	5.80	5.50	6.00
No-Fire Area	6.24	6.89	6.53	6.83	6.05	5.60	5.63	6.25
Kill Zone	6.20	6.78	6.24	6.83	5.80	5.64	6.06	6.33
Artillery Air Corridor	6.32	6.65	5.94	6.33	6.73	6.36	6.06	6.00
Flight Corridor	6.48	6.78	6.16	6.83	6.65	6.64	6.13	6.33
Fields of Fire	5.65	5.53	5.50	6.60	5.50	5.45	5.88	6.00
LINES								
FEBA	6.60	6.44	6.78	7.00	6.55	7.00	6.44	6.27
FLOT	5.98	6.07	6.07	6.40	6.19	5.73	5.25	6.45
Unit Sector Boundaries	5.41	5.44	5.82	5.33	5.10	5.00	5.27	6.00
Phase Lines	5.63	6.06	6.44	6.00	5.05	4.82	5.27	5.92
Axis of Advance	5.61	5.38	6.29	6.40	5.26	5.18	5.53	5.64
Planned Course	5.99	6.44	6.06	5.83	5.91	5.45	5.87	6.08
OBSTACLES								
Wires	6.80	6.94	6.72	6.83	6.83	6.91	6.56	6.83
Emplacements	5.90	5.86	6.17	5.17	5.71	6.60	5.88	5.73

	ALL AVIATORS	229TH ATK HEL BN	2/17 CAV	163RD AVN CO	159TH ASLT SPT HEL BN	101ST AVN BN	158TH AVN BN	CAREER TNG DIV
Minefields	5.27	4.50	5.41	4.17	5.43	5.36	5.57	5.90
Tank Traps	4.34	4.86	4.94	4.00	3.68	5.00	3.77	4.27
Blown Bridges	4.62	4.79	5.12	3.67	4.45	5.18	4.36	4.27
Roadblocks	4.26	4.79	4.94	3.67	3.57	4.91	3.85	4.00
FLIGHT DATA								
Planned Airspeed	5.74	5.50	6.11	5.80	5.80	5.50	6.08	5.38
Planned Heading	6.06	5.86	6.22	6.60	6.19	5.70	6.14	5.89
Planned Arrival Times	6.05	5.77	5.10	6.00	6.21	6.40	6.57	6.00
Wind Data	5.83	5.75	5.38	6.00	6.19	6.20	5.77	5.25
Time Tick Marks	5.66	5.33	5.25	5.83	5.81	5.82	6.27	5.36
Barrier Features	5.58	4.88	5.87	6.00	5.73	5.64	6.00	5.09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